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Fish Habitat Improvement Handbook

Technical Publication R8-TP 7

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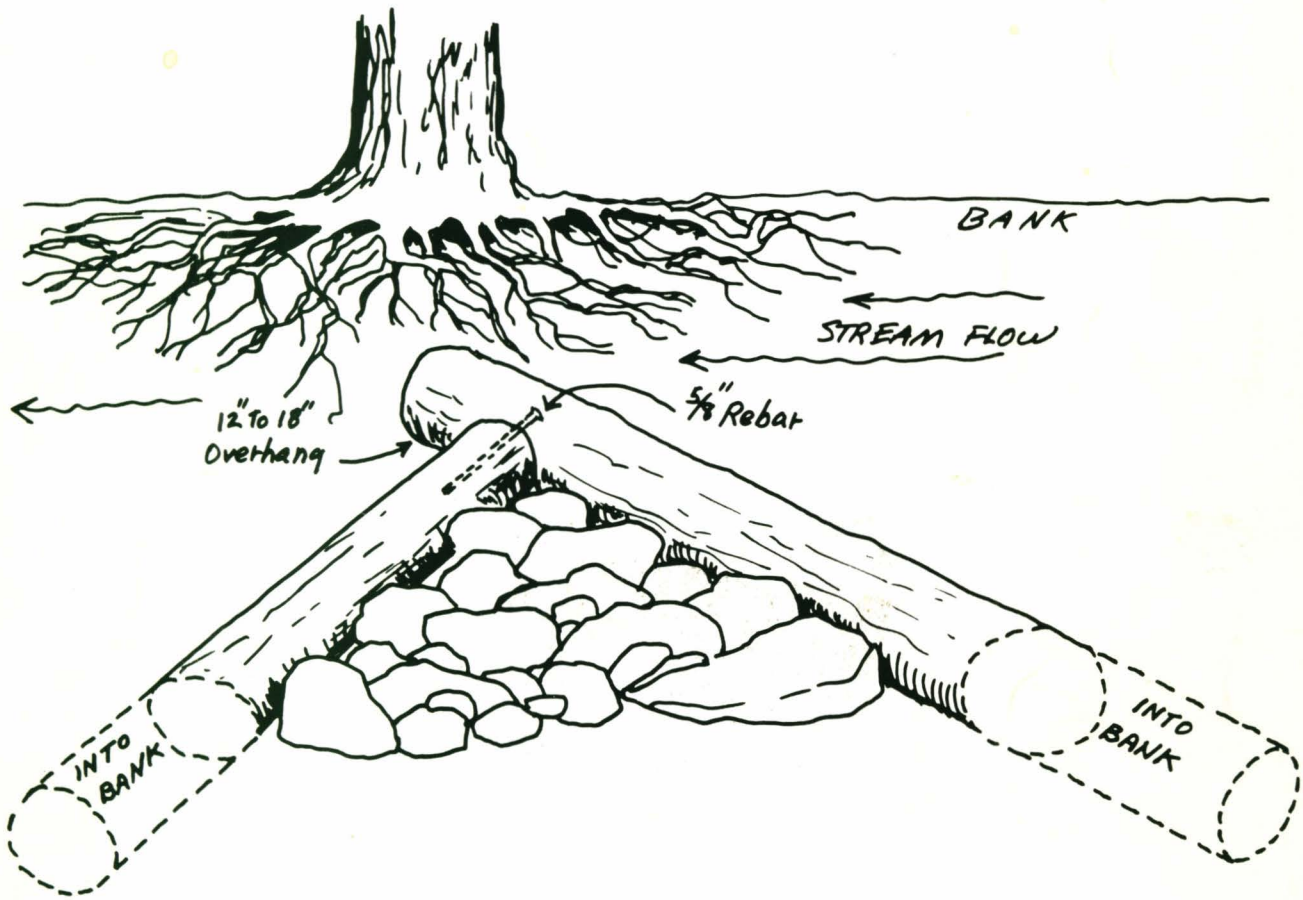

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COMMON MEASURES AND THEIR METRIC EQUIVALENTS

1 inch . . . . . .2.54 centimeters
1 foot . . . . . .0.3048 meter
1 mile . . . . . .1.6 kilometer

FISH HABITAT IMPROVEMENT HANDBOOK

BY
MONTE E. SEEHORN
Regional Fisheries Biologist

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INTRODUCTION

Purpose

This handbook provides fishery managers with structural designs that may be used to correct stream fish habitat deficiencies over a broad range of existing conditions. With the exception of the fish barrier, the primary objective of the designs is to improve instream conditions by creating deeper water and overhead cover.

Scope and Origin of Designs

The designs in this handbook are for structures that can be installed using hand labor. Little or no heavy equipment is required. Several excellent designs were not included in this manual due to complexity of construction, high cost, the need for heavy equipment, and access requirements. Some of these designs were also omitted because their success was dependent upon very low gradients and water levels more stable than the majority of southeastern streams.

Most of the designs described are modifications of designs in other stream improvement publications. No changes were made in two of the designs selected. In preparing this manual, the designs were analyzed and selected to satisfy specific objectives. The original designs were then modified, as needed, during field testing. The majority of testing was conducted on trout streams in the Southern Appalachians – including Virginia, North Carolina, Tennessee, Kentucky, Georgia and South Carolina – although limited testing has been attempted in several warmwater streams.

Cover or added depth is created through scouring action. The scouring causes localized movement of instream sediments and, at times, bank sediments. Deflectors used to create meanders in a straight or channelized section of stream also displace sediment. This should not be cause for concern, since long term benefits far outweigh any temporary adverse impact. Normally, such local scouring creates only a minor addition of sediment. The primary effect is a shifting of bedload material a short distance downstream, creating the beginning of another meander. As meanders increase and the gradient decreases, current velocity and sediment carrying capacity is reduced. Creation of these stream meanders, along with deeper water and improved cover, can mean the difference between marginal and better than average fisheries. In streams where flow sinks into deep gravel or rubble deposits during drought periods, creation of holding pools is critical.

Range of Habitat Conditions in Tested Areas

In tested areas, habitat conditions ranged from steep gradient reaches (300-500 feet per mile) in which the primary substrate was boulders and large rubble, to very low gradient reaches (less than 10 feet per mile) with shifting sand substrate.

Stabililty of streams in the tested areas ranged from excellent to very unstable. Some stream channels in Virginia and a few other southeastern areas change characteristics annually due to extensive bedload movements.

It seems logical that the wide range of conditions encountered are duplicated in other regions of the United States. Therefore, structures suitable for a 15-foot wide, 3-percent gradient, gravel bottom stream in the Southeast would probably be suitable, with minimum modification, for streams with similar characteristics in other sections of the country.

Principles of Stream Management

Goals for improving habitat should be based upon overall management goals of the resource (fishery) being affected. When the overall goal is improving a fishery for large resident brown trout, the addition of overhead cover should receive highest priority. When the overall goal is maximizing "put-and-take" fisheries, the addition of structures that will create large open pools may have highest priority. An anadromous fishery requiring maximum spawning habitat development would necessitate yet another approach.

In reaching the selected goal, consideration should be given to the quality and quantity of development, stability of stream and riparian areas, effects upon diversity, and aesthetics of the program. Quality, quantity, and stability are directly tied to economics and must be accurately assessed for development of a viable project. Diversity is important in any ecosystem, and projects should be designed to meet the broadest habitat requirements that can be encompassed while still meeting the basic project goals. In some projects, aesthetics may be the primary consideration when selecting structure design. For example, wedge dams, K-dams, and double wing deflectors are used to create scour pools. Under certain conditions, any one of these designs, used exclusively, would probably achieve fish production goals. Overall aesthetics and diversity would be increased, however, if all three designs were used in the same project.

Proper planning procedures are a necessity when implementing stream improvement programs. The following action plan provides a logical sequence for implementing programs.

(1) Examination and identification of limiting factors.
(2) Prescription to correct deficiencies. Recommendations should be tailored to individual stream needs and should be based upon overall goals.
(3) Treatment by prescription. Base priorities upon overall management objectives.
(4) Evaluation of project to determine if short-term goals were met.
(5) Maintenance of project to insure completion of long-term goals.

Cost/Benefit Estimates

Cost estimates for installation, given in crew days (8 working hours), are based on a four- to six-person crew working in relatively accessible areas using handtools, and cutting logs on site. Installation at times other than low flow periods increases cost and reduces quality of the finished product.

Structure durability varies significantly, depending upon the size of logs and the amount of structure exposed to air. Logs from small fast-growing trees, containing little heartwood, deteriorate rapidly. Older trees with a high percentage of heartwood, and rot resistant species such as black locust and eastern hemlock, are most suitable when exposure to air is a problem. When submerged, all species including yellow-poplar, yellow pine, oak, and white pine are relatively durable. (The species listed above are found in the Southeast and may not be available in other sections of the country.)

With proper installation and occasional maintenance, all structures discussed in this publication should provide benefits a minimum of 20 years. Structures placed by Civilian Conservation Corps crews in the 1930's have lasted over 50 years. When prorating costs and benefits, a reasonable compromise would be 25 to 30 years.

Recordkeeping

Recordkeeping is an important, but sadly neglected, aspect of many field projects, including stream habitat work. Due to the dynamic nature of watercourses, it is especially important to keep detailed records. Occasional maintenance is a necessity and requires specific information concerning location and design of the structure. A simple form, such as that shown in figure 1, provides space for recording location, design details, materials used, cost estimates, evaluation data, and maintenance performed on individual structures. In addition, a sketch (figure 2) of the entire project is invaluable to maintenance crews and other personnel when locating structures.

Equipment and Supplies

The following list describes the equipment and supplies needed by a four- to six-person crew.

- Chainsaw.
- Chainsaw winch.
- Hand winch ("come-along").
- Heavy wire, such as "hogwire" or chain link fencing (36-42 inch width).
- Fiberglass cloth or fine mesh wire, such as hardware cloth, for use in conjunction with the heavy wire.
- Planking — an alternative to the heavy wire and fiberglass cloth.
- Staples for attaching wire and cloth to log.
- Handtools — clawhammer, axe, mattock (2), pick, 5- to 6-foot steel pry bar (2), shovel (2), fire rake (2), sledge hammer (2), 50 foot fiberglass tape, peavy or canthook (2), log carrier (one per two crew members), wire cutters, pliers, cable and clamps.
- Logs — Size of logs varies with size of stream and type structure. Whenever available, use logs 14 to 16 inches or more in diameter.
- Steel pins in two sizes cut from reinforcing rod ("rebar"):

  18 to 22 inches long and 5/8 inch in diameter; and 48 to 54 inches long and 3/4 inch in diameter.

DESIGN SPECIFICATIONS AND APPLICATIONS

General Information

As mentioned in the previous section, size of logs used is somewhat dependent upon stream size. On shallow streams less than 12 feet wide, 10- to 12-inch logs may be suitable. As a general rule, however, logs should be 14 inches or more in diameter. In this type work, the axiom "bigger is better" usually does apply!

The distance logs are dug into the streambank is dependent upon bank stability characteristics. In the most stable situations, where logs can be locked behind boulders or root systems, 3 to 4 feet may be adequate. When banks are composed of unconsolidated gravel, rubble, or other unstable material, 10 feet or more may be required. Under these conditions, heavy equipment (front-end loaders etc.) may be necessary for excavation.

The 18- to 22-inch pins are used to join logs. The 48- to 54-inch pins are driven through the logs and into the stream bottom to hold the logs in place. A cutting torch can be used to shape points on the pins. Some type slot or hole should be cut through the logs to facilitate driving the pins. The simplest and quickest method is to cut a slot with a chainsaw. When driving pins through extremely hard wood such as black locust, a power drill may be necessary.

A soft rolled steel cylinder 6 inches long by 2 inches in diameter with a 3/4- or 1-inch diameter hole drilled 3 inches deep into its length, can be used as a "driving head" for the pins.

Logs should be bedded a minimum of several inches into the streambottom. This is especially critical when installing dam type structures. It is almost impossible to bed the main logs to an optimum depth with hand tools. Where possible the main K-dam log should be dug at least half its diameter into the existing streambed. Spillway height should be from 6 to 12 inches. The main wedge dam logs at the apex should be dug to similar depths into the streambottom. They can then be angled upwards toward the streambank, with the bottom of the logs near the water surface at the edge of the stream. Structure height would be the minimum necessary to achieve habitat objectives.

Structure locations should be selected during lowest flow periods. Since lowest annual flows in the Southeast generally occur in late summer or early fall, site selection and construction should be completed between July and October.

STREAM IMPROVEMENT STRUCTURE

NATIONAL FOREST Nantahala DISTRICT Wayah

Stream Big Indian Cr. Structure # 1

Location of structure First structure above the mouth of Big Shoal Cr. (approx. 100')

Type structure Wedge dam Date of construction Sept. 1966

Materials used Hemlock logs, Hogwire, Hdw. cloth

Man days & estimated cost of structure 3 man days - $225

Purpose of structure to create a pool & improve fish cover

Evaluation of structure at least one year after construction structure has created a pool 30" deep in a stretch of water normally only a few inches deep

Maintenance performed (date & brief description) No maintenance to date (6/84). Only work needed at present is minor replacement of rocks in wings (see sketch).

SKETCH

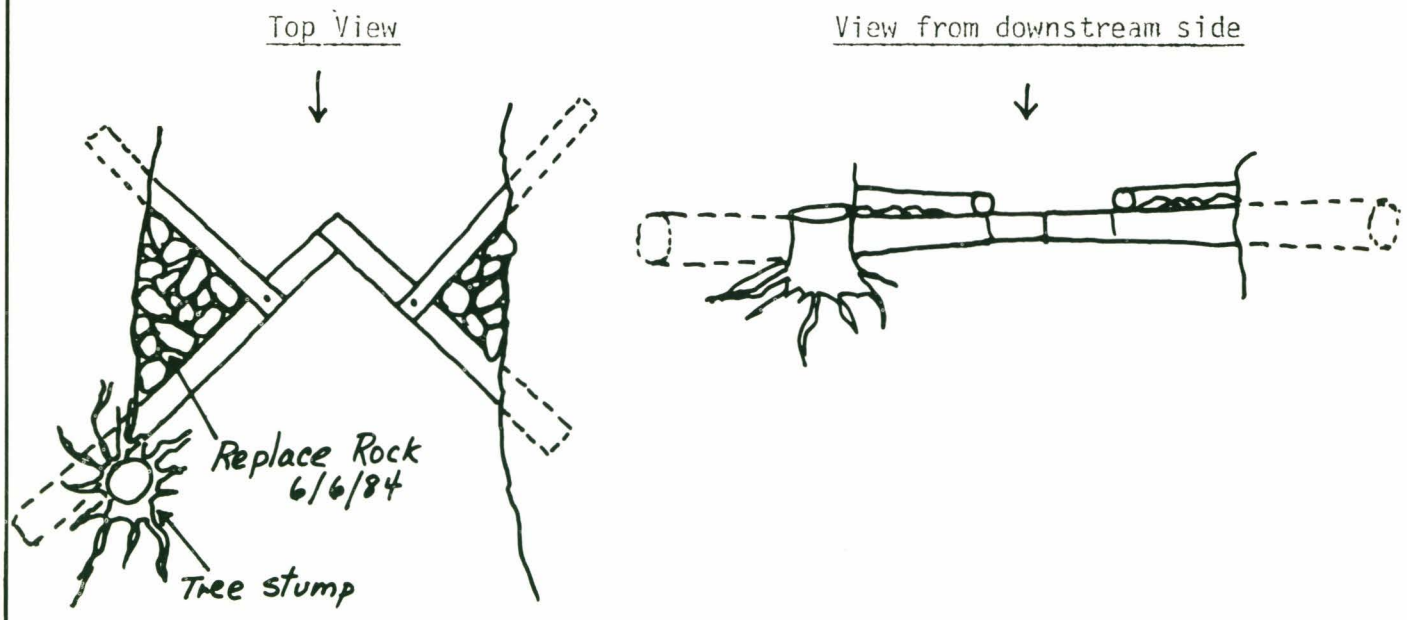


Figure 1.—Example of record form.

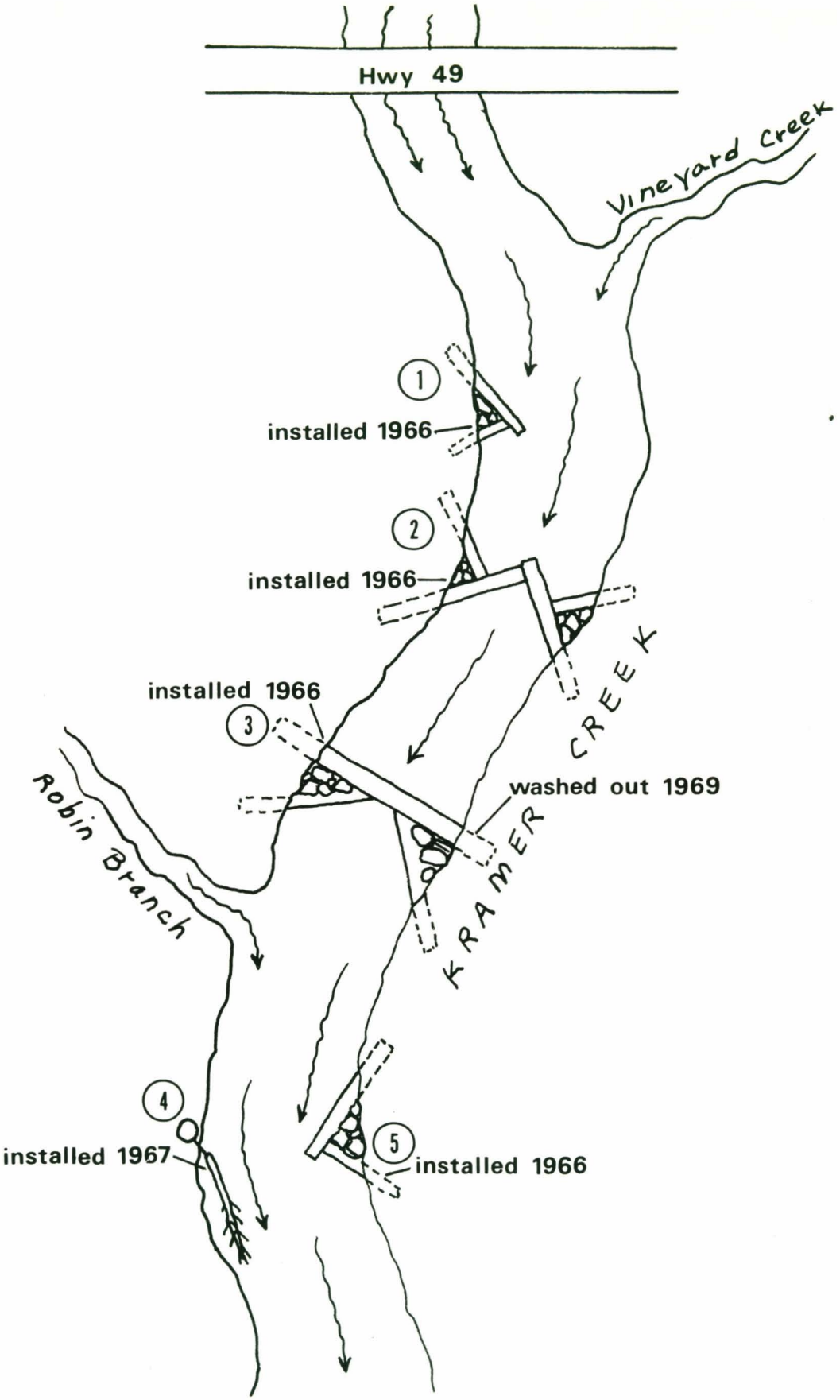


Figure 2.—Kramer Creek stream improvement project.

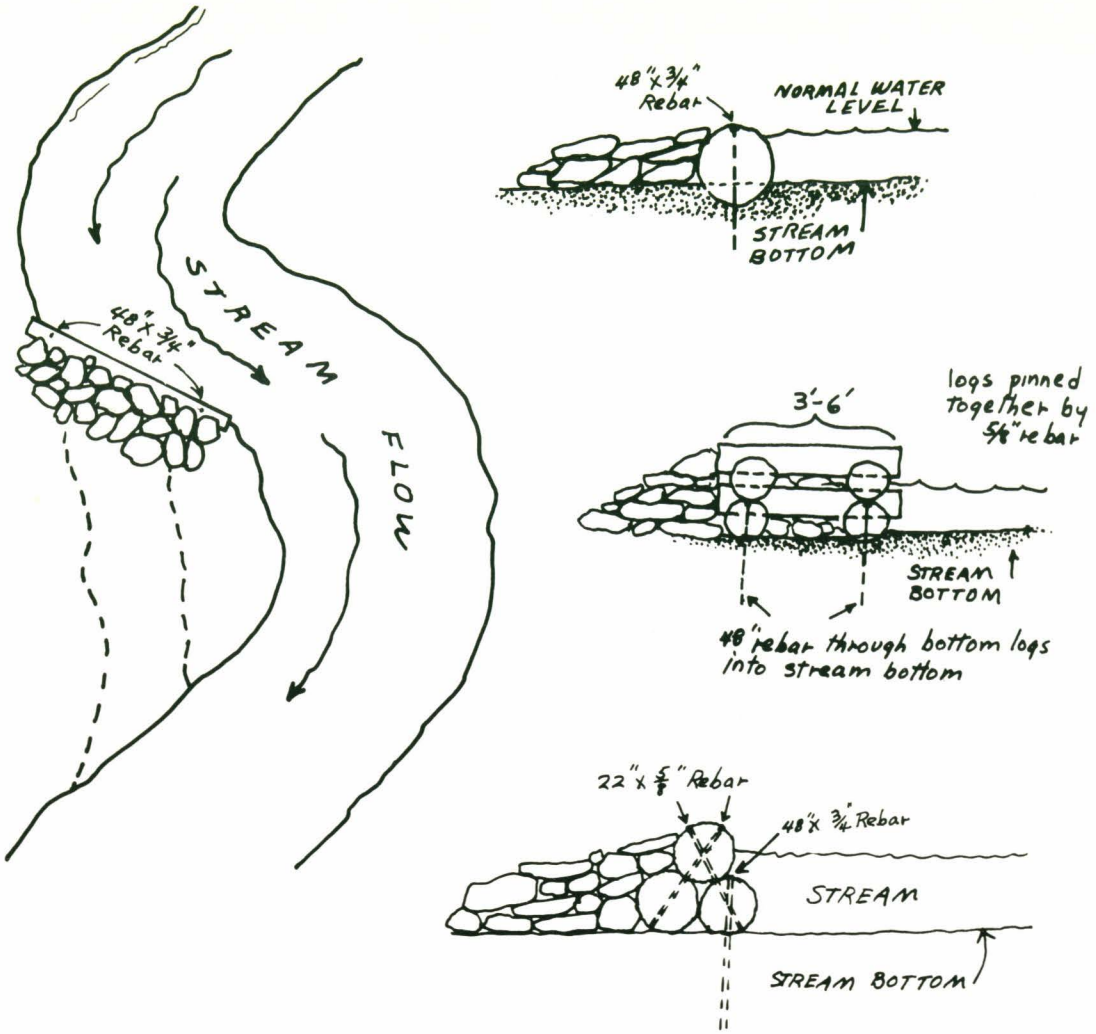


Figure 3.—Channel block.

Channel Block

Purpose — In any improvement project, top priority should be given to consolidating braided channels into one. Late summer flows moving through several small channels are often insufficient to hold fish, and in some cases will not allow up or downstream movement. By consolidating flow into a single deeper channel, additional fish holding habitat can be created. In addition, potential temperature problems can be avoided (wide, shallow areas tend to warm quickly), and migration routes restored (figure 3).

These structures may also be used to maintain stream meanders where high water has created an oxbow. The structure holds normal or moderately high flows in the meander channel, but still allows flood waters to overflow into the blocked channel.

Design — Since these structures are placed in critical areas bearing the brunt of flood waters, special care must be taken to insure stability. Single logs may be used with some success in small streams. However, triple log and crib structures give better results and are less ple log and crib structures give better results and are less likely to wash out in larger (over 15 feet wide) streams. As a general rule, triple logs can be used in relatively stable streams 15 to 25 feet in width. The log crib filled with gravel and rubble is generally more suitable for larger unstable streams.

Placement — Channel blocks are usually installed in braided channels or at the beginning of stream meanders where flood waters have created an oxbow.

Advantage — Triple logs or cribs tend to leak less water than single logs although single logs are easier and cheaper to install.

Disadvantage — Single logs are less efficient than either of the other structures, but are considerably less expensive to install. Cribs are the most expensive to install but are the most effective of the three structures.

Cost — Generally three to four single log structures or two to three triple log structures can be installed per crew day in 15- to 20-foot wide channels. One hand-filled crib may require from 1 to 2 days to construct.

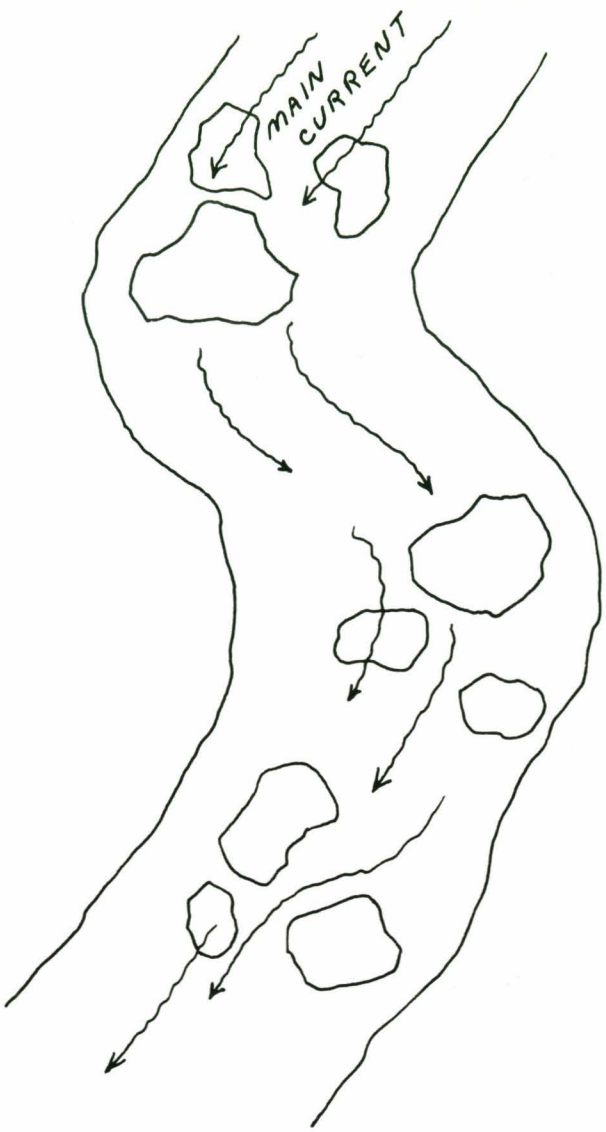


Figure 4.—Boulder placement.

Boulder Placement

Purpose — When placing boulders, the primary goal is to provide overhead cover and resting areas (figure 4). Added depth is also created by the scouring resulting from reduced channel capacity and increased current velocity.

Design — For best results, use the biggest, most irregular boulder that can be handled. The more irregular the surface, the more "pocket" or hiding space will be available.

Placement — Boulders can be used in most stream situations, including riffles, runs, flats, glides, and open pools, although greatest benefits are likely to be achieved in currents exceeding 2 feet per second. Where channel width allows, placing boulders in groups provides the best results.

Advantage — No other materials are needed for installation. Boulders also present a more natural appearance than other structures.

Disadvantage — Boulders are not always available at project sites. Heavy equipment may be necessary to move them into place.

Cost — The cost depends upon the distance boulders are moved and the type of equipment that is used. If conditions are suitable and boulders are plentiful, a front-end loader could place 25 or more a day.

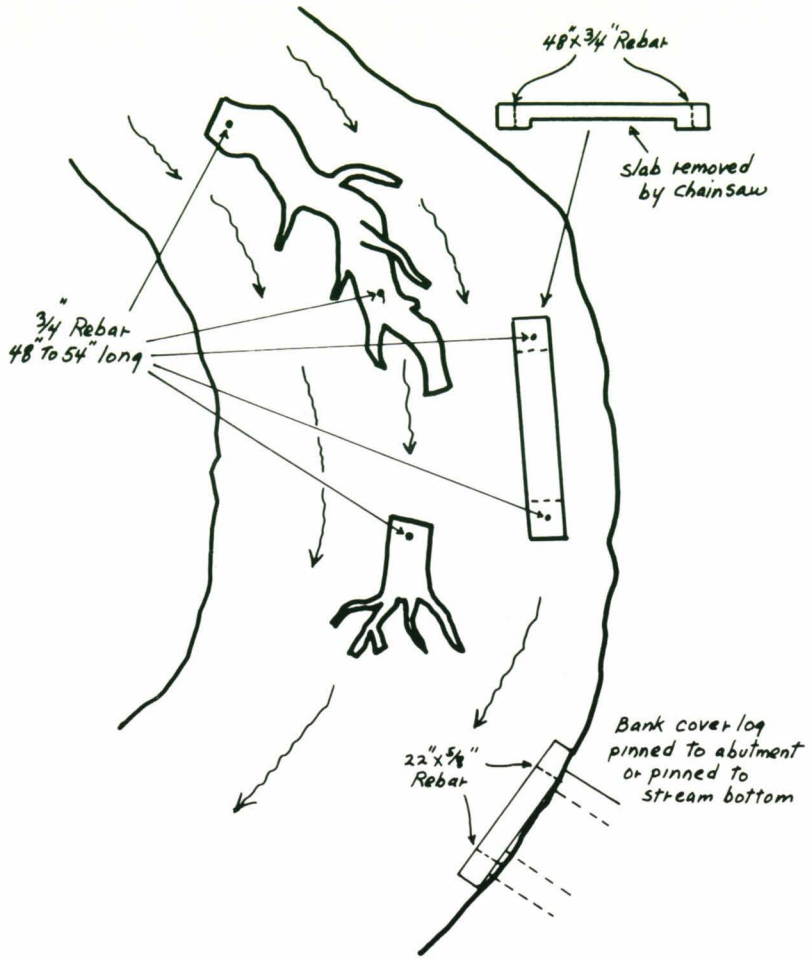

48"x3/4" Rebar
Slab removed by Chainsaw
3/4" Rebar 48" to 54" long
22"x5/8" Rebar
Bank cover log pinned to abutment or pinned to stream bottom

Figure 5.—Cover logs.

Cover Logs

Purpose — Cover logs provide overhead cover in sections of stream where existing water depth is adequate but cover is lacking (figure 5).

Design — Cover logs can be any shape, length, or size, but best results are attained with large (over 16 inches diameter), crooked, cull trees. These provide an irregular surface, resulting in maximum turbulence along the edge of the log. Logs with stubs of limbs several inches long create additional turbulence and spot scouring. Large stumps also provide excellent cover. Where such material is unavailable and logs are small and straight (use nothing less than 10 inches), a slab can be chainsawed from the bottom of the log creating a "bench" effect.

Logs placed out in the channel can be pinned into gravel and rubble streambottoms with 3/4-inch reinforcing rod ("rebar") 48 to 54 inches long. Logs placed against streambanks can be anchored with reinforcing rod as mentioned above, or pinned to abutment logs in the bank with 5/8-inch rebar. Where bedrock is prevalent, a portable jackhammer can be used to drill holes. Logs can then be attached to steel pins or bolts placed in the holes.

Placement — Ideal locations are open pools and flats at least 6 to 8 inches in depth. In these locations, logs are placed parallel, or at a slight angle, to the flow. Logs installed along stream banks are usually placed at a slight angle to the flow. The best bank locations are in stream meanders or in conjunction with deflectors (see "Deflector and Cover Log").

Advantage — Cover logs are the simplest and least expensive of the log structures discussed, yet under certain conditions they provide an ideal cover. Of all log structures, cover logs present the most natural appearance. In addition, they are suitable for use in any size stream, and have less impact on channel capacity and flow characteristics than other structures. Maintenance of these structures is minimal.

Disadvantage — Unless the logs are large or highly irregular in outline, they may become partially or completely covered with sediment deposits. Results are generally not suitable in water less than 6 to 8 inches in depth. In sandy or other highly unstable subtract, there may be no feasible means of anchoring cover logs.

Cost — When logs are handy and only pins are used to anchor them, a crew can install 10 or more cover logs a day. When abutments must be "benched" or dug into banks, less than 10 structures a day would be more realistic.

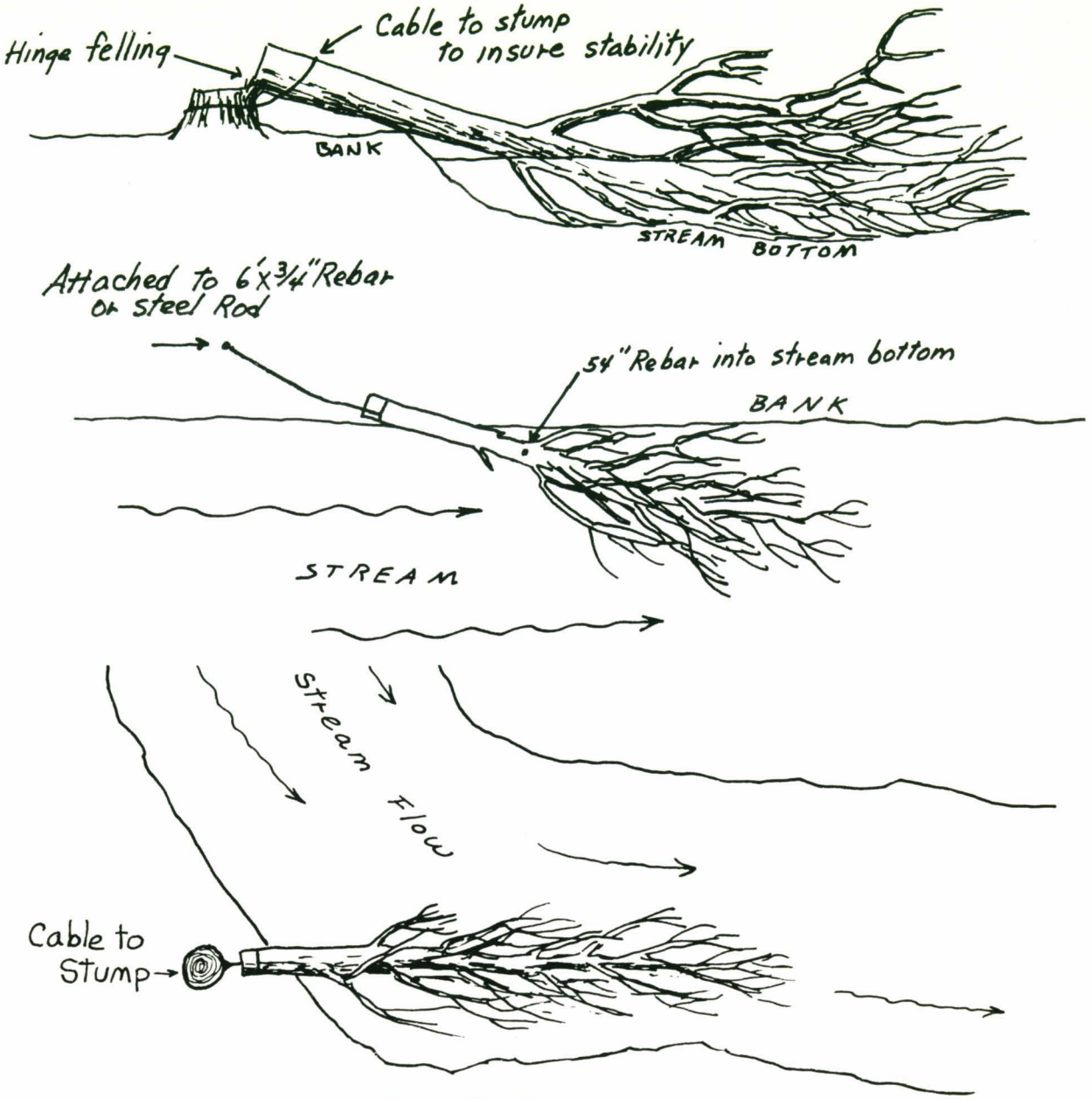


Figure 6.—Tree cover.

Tree Cover

Purpose — Trees placed in proper locations provide several benefits. They provide excellent overhead cover and an ideal substrate for aquatic organisms. In addition, trees serve as deflectors to constrict wide, shallow channels, thus increasing stream velocity, removing sand or fines, and creating deeper water.

Design — Trees are normally cut in place and felled directly into the stream (in a downstream direction) with the axis at a 30- to 45-degree angle to the streambank (figure 6). If the tree is located properly, it can simply be hinge-felled in place. If not, it can be cut, placed, and then attached with cable to the stump or a 6-foot rod driven into the ground. In smaller streams, understory shrubbery, such as rhododendron, can be used in the same manner as trees. Where trees are hinge-felled, they should also be cabled to the stump to insure stability.

Placement — Trees or shrubs can be placed in any section of stream large enough that the installation would not create serious bank erosion. The greatest benefits are probably realized in wide, shallow streams with sand or gravel substrate.

Advantage — Under certain conditions trees can provide excellent benefits with little expense. In larger streams with unstable substrate and no means of attaching cover logs, trees may be the only feasible alternative.

Disadvantage — Small channels may preclude the use of trees. Suitable trees may not always be available in the immediate vicinity.

Cost — Where trees can be hinge-felled or dropped in place, two workers could cut and cable eight to twelve trees a day. Where trees must be moved by heavy equipment, four to eight trees a day would be a more reasonable figure.

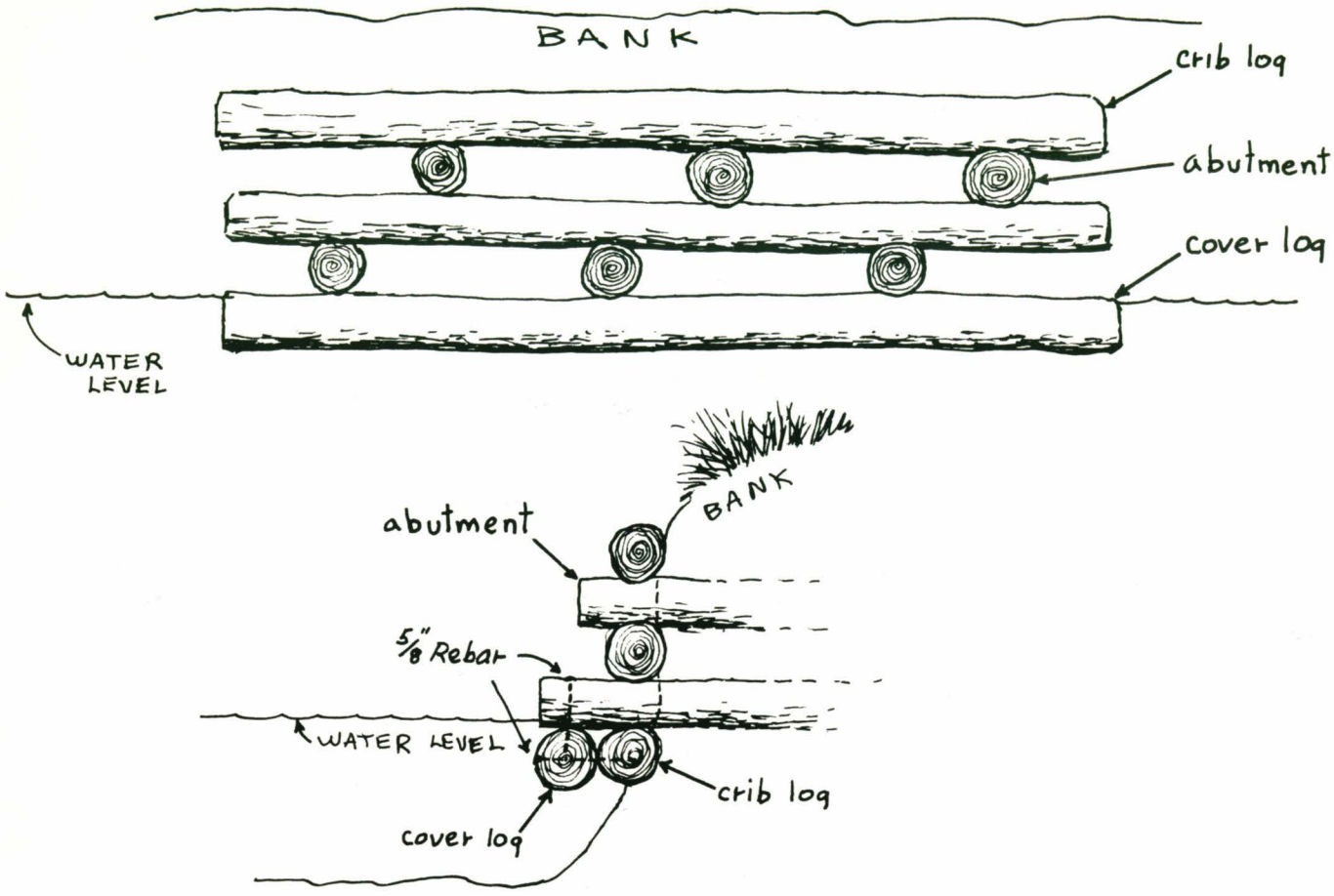


Figure 7.—Bank crib with cover log.

Bank Crib with Cover Log

Purpose — The bank crib with cover log is used to protect unstable banks, at the same time providing excellent overhead cover for fish.

Design — The design is a simple crib with abutment logs extending as far back into the bank as necessary to assure structure stability (4 to 6 feet in stable soils and 10 feet or more in unstable soils). The lower abutment logs should be near water level and should extend 18 to 24 inches from the bank. The cover log can then be pinned to the crib log and the lower abutment (figure 7). The structure can be from one to several logs high, depending upon bank height. Cover logs can also be attached with cable to gabion mats serving the same purpose (figure 18).

Placement — This structure can be used in any area with a suitable streambank.

Advantage — The design accomplishes two objectives. It insures bank stability and creates excellent cover at the same time. The only materials required are logs on site and, 5/8-inch rebar to join the logs.

Disadvantage — Installing the structures is fairly time-consuming, due to the amount of digging required. Water adjacent to some eroding banks requiring abutment work is also too shallow to make effective use of cover logs.

Cost — One crew should install 20 to 30 feet of crib (two crib logs high) per day if logs are reasonably close to the site.

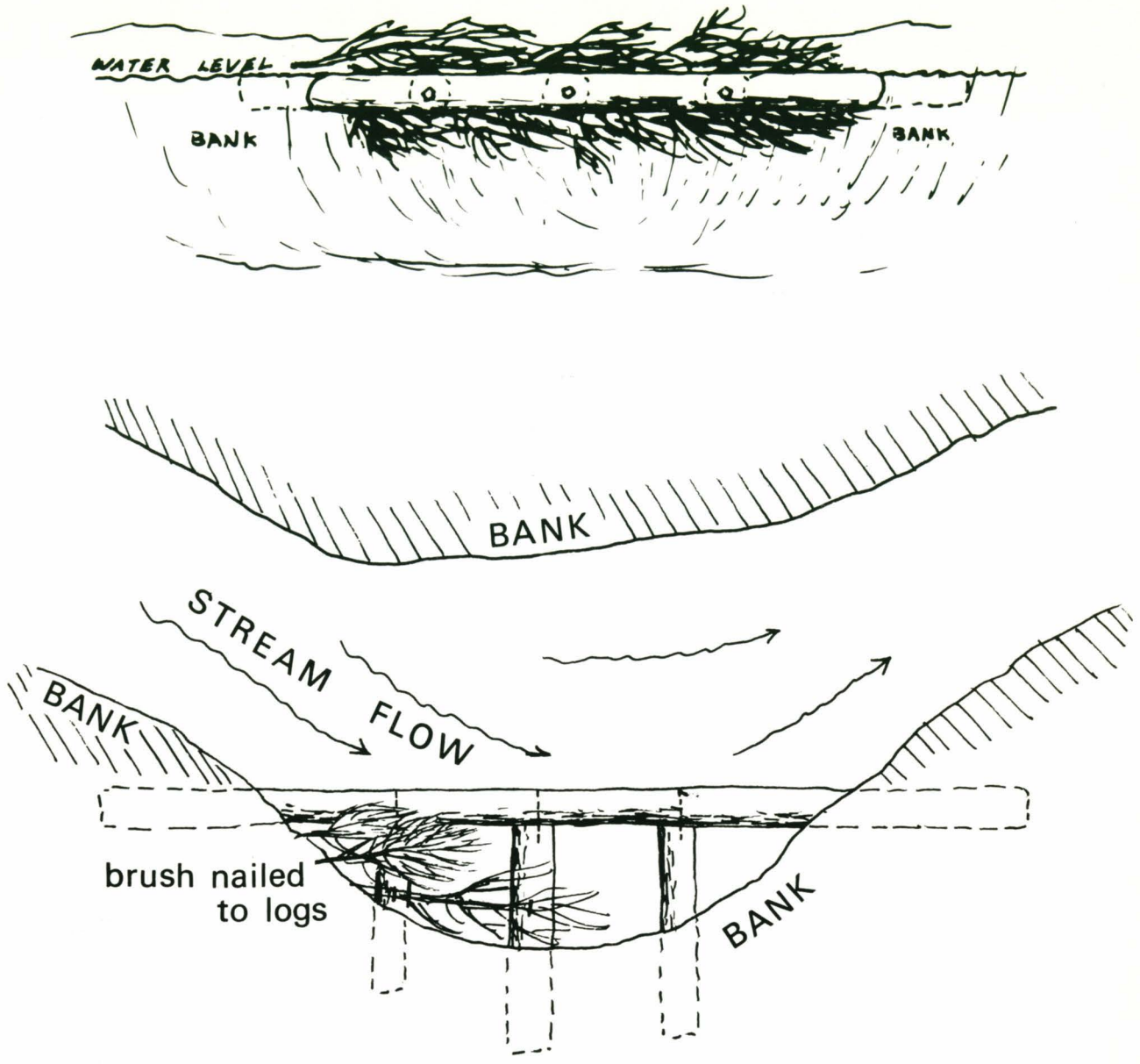


Figure 8.—Log and brush shelter.

Log and Brush Shelter

Purpose — This device is designed to provide overhead cover. A certain degree of streambank protection is also provided, although less than with cribs. The brush and slash attached to the platforms also harbors aquatic and terrestrial insects eaten by fish.

Design — The finished shelter is simply a rack or shelf projecting from the bank to which brush or coarse logging debris can be attached (figure 8). Brace or abutment logs and the ends of the main log should be dug several feet (4 to 15 feet depending upon distance spanned and bank stability) into the bank and then pinned together with $^{5}/_{8}$-inch rebar. The life of the structure will be much greater if all logs are submerged. Brush or debris should be attached so that portions are above and below the water surface.

Placement — These structures are most suitable for use in low gradient stream bends where open pools are already present. Placement in conjunction with a deflector can enhance results.

Advantage — Materials are cheap, and a comparatively large area of overhead cover is provided at each site. Brush provides maximum surface for both terrestrial and aquatic insects.

Disadvantage — The opportunity for installing these structures is limited to relatively few situations. Extensive excavation is required if streambanks are high.

Cost — Output should range from the two structures per crew day on a small stream with low banks (2 to 4 feet) to one per day on larger streams with higher banks.

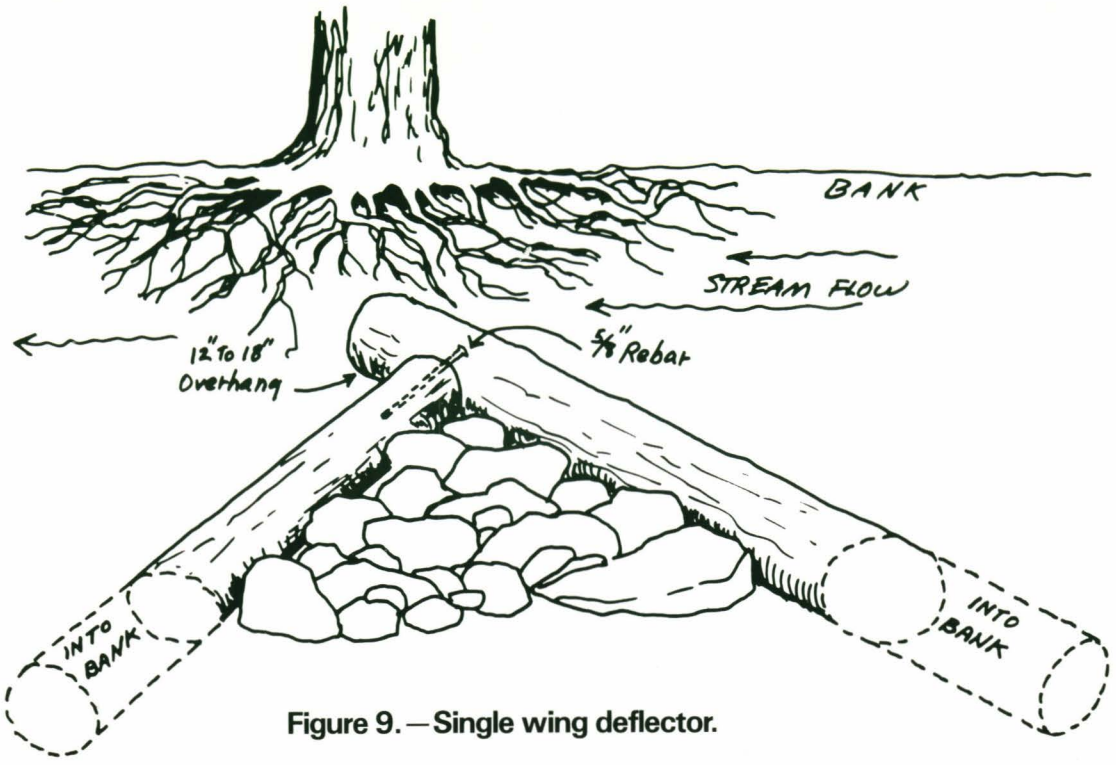


Figure 9.—Single wing deflector.

Single-Wing Deflector

Purpose — Single-wing deflectors are normally installed to constrict and divert flows so that stream meanders and pools are formed by scouring and relocation of fine sediment and gravel (figure 9).

Design — Logs should be at least 14 inches in diameter, except in the very smallest streams, and should be dug several inches into the streambed. The finished structure should rise 6 to 18 inches above normal summer flows, but should never exceed streambank height. The higher the structure, the greater the scouring action will be during storm flow. Streambed width must be narrowed by 70 to 80 percent to achieve desired results.

Logs are held in place by 5/8-inch rebar at the junction of the two logs, and by extending 4 to 6 feet of the main log into the streambank. In streams over 10 feet wide, 3/4-inch rebar, 48 inches long, should be driven through the main log into the streambottom 3 to 6 feet from the tip of the structure.

The main deflecter log is placed at approximately a 30- to 45-degree angle to the streambank. The brace log is pinned to the main log 18 to 24 inches from the tip at approximately a 90-degree angle. This angle can vary somewhat, but should be such that waters overtopping the structure spill toward the center of the stream rather than the streambank. Large flat rocks should be used for fill material when available, and placed shingle fashion for greater stability. Sod or soil and seed can be placed as a final measure to insure stability and improve aesthetics. Where flooding is a problem, the sod can be held in place by fine mesh wire or similar material.

Placement — Deflectors are quite versatile and can be placed in sites ranging from steep gradient chutes with heavy rubble bottoms, to wide shallow flats with sand or silt substrate. The most suitable locations are in wide shallow riffles or flats. When possible, water should be diverted into a relatively stable section of streambank. Ideal locations are where water is diverted into large boulders, overhanging trees or stumps, and sections of bank with interlocking root systems that can be undercut without sloughing significantly. Where sloughing would occur, an abutment or cover log can be added to hold the bank in place and to provide overhead cover (see "Deflector and Cover Log"). Where water is diverted against boulders, stumps, or other stable objects with a short span, the apex or tip of the deflector should be placed opposite or slightly upstream from the object. Where cover logs or extensive root mats provide a longer surface, the tip of the deflector should be located approximately one-third of the distance above the lower end of the log or root wad. By placing the deflector towards the lower end, the constriction or damming effect can create deeper water along the entire upper two-thirds of the log. These devices are suitable in streams up to 30 feet or more in width.

Advantage — Deflectors are significantly cheaper to install than dam type structures, and can be placed in sections of stream where streambank height is too low for dams. They are also suitable for use in streams too wide for dams.

Disadvantages — When maximum depth is the objective, dam type structures generally create a deeper scour pool than deflectors. In high gradient reaches with flows exceeding 3 feet per second and substrate composed of large rubble or other coarse material, dams that break gradient and more effectively reduce current velocity generally provide better cover and resting or holding areas.

Cost — Three to four deflectors can be installed per crew day in streams 10 to 15 feet wide.

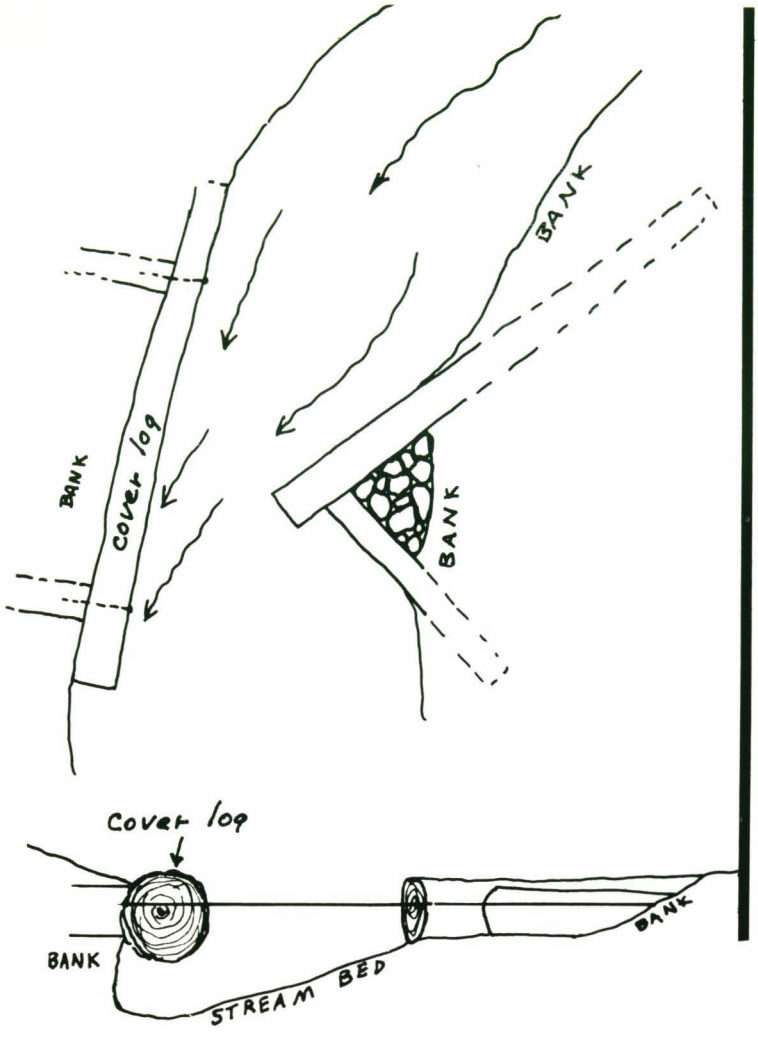


Figure 10.—Deflector and cover log.

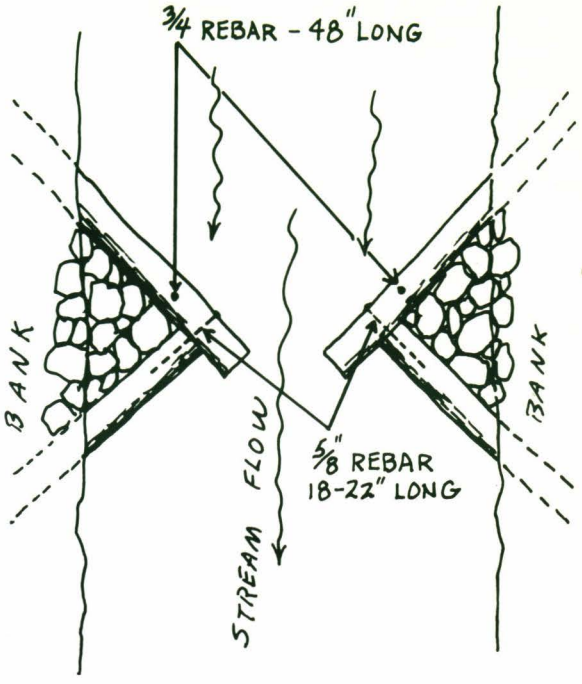


Figure 11.—Double wing deflector.

Deflector and Cover Log

A deflector and cover log is similar to a single-wing deflector. The cover log insures bank stability where suitable boulders, tree stumps, or stable banks are lacking (figure 10). Two to three deflector-cover log combinations can be installed per crew day in streams 10 to 15 feet wide.

Double-Wing Deflector

Purpose — The double-wing deflector is used to create mid-channel pools through scouring action in shallow sections of streams.

Design — This combination of structures includes two single-wing deflectors placed on opposite streambanks with the two apex's narrowing the stream channel by approximately 80 percent (i.e., a 20-foot wide channel would be narrowed to 4 feet) (figure 11). This degree of constriction in gravel and small rubble usually results in a scour pool extending 18 to 24 inches under the tip of each deflector.

Placement — This combination of structures is especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log combinations, and where banks are too low to install wedge or "K" dams.

Double-wing deflectors can also be used in low gradient sections, but in most cases the small meanders created in such areas by a series of deflector-cover log combinations are an advantage not provided by the double wing deflector.

Advantage — The double-wing deflector is suitable for use in situations where deflector-bank logs and small dams are not as effective or feasible. If installed properly, scour pools equal in quality to those produced by small dams can be created at less cost. Maintenance, in addition to initial cost, is significantly less than on small dams. Double-wing deflectors are suitable in streams up to 30 feet or more in width.

Disadvantage — These structures provide only one break in gradient or resting area (the scour pool), while dams often provide a small flat or resting area above the structure in addition to the plunge pool.

Cost — The paired structures can, in most cases, be installed at two locations per crew day in smaller streams (10 to 15 feet wide). In large streams, one and one-half structures per day would be realistic.

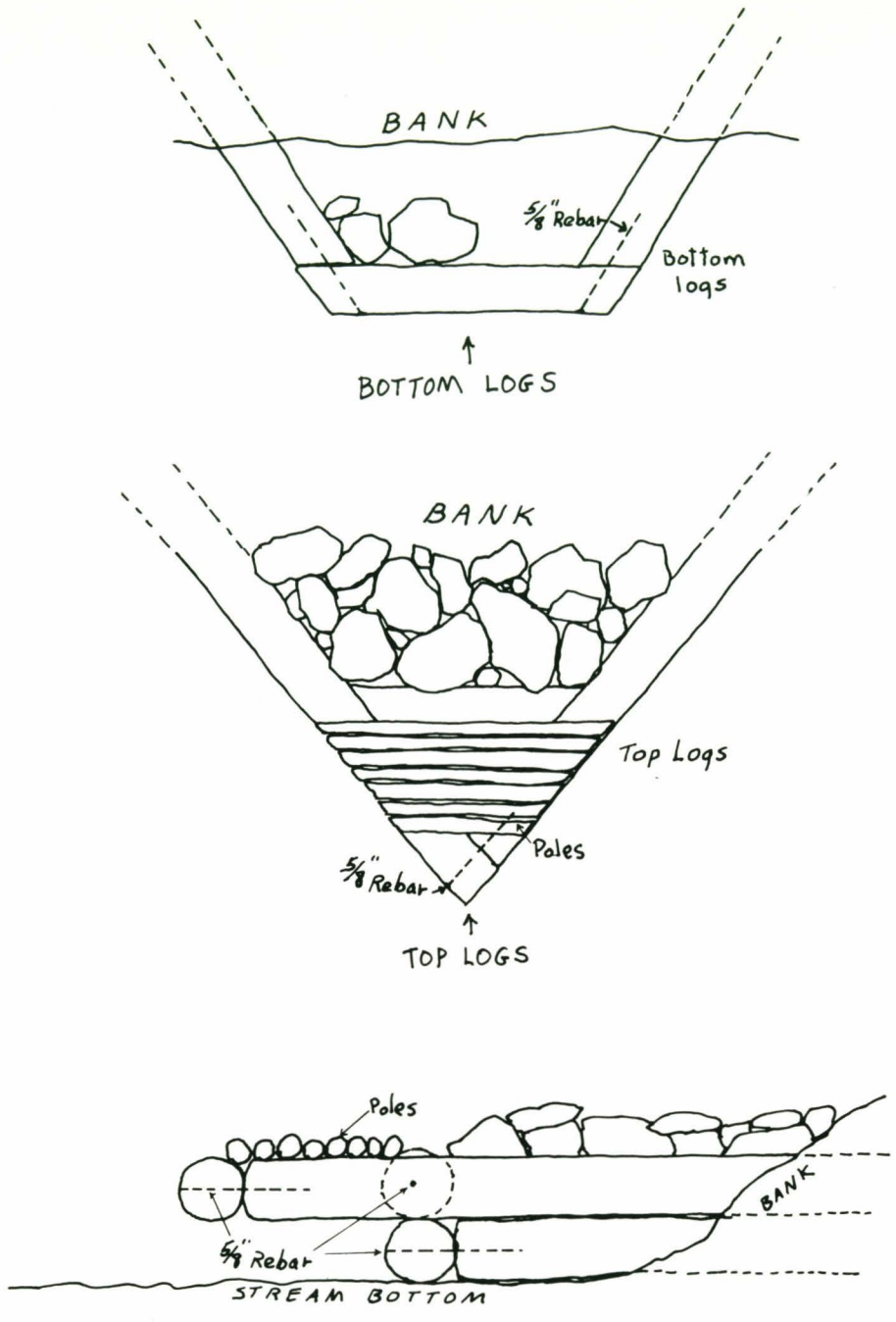


Figure 12.—Tip deflector.

Tip Deflector

Purpose — The tip deflector is a variation of the single-wing deflector designed to provide maximum overhead cover.

Design — This structure is two logs high, with the upper logs extending 2 to 4 feet past the bottom logs, thus creating a shelf effect (figure 12). It can be placed alone or in pairs.

Placement — This structure should be most suitable in low gradient sections of streams 15 feet or more in width.

Advantage — When installed properly, tip deflectors create the maximum amount of overhead cover.

Disadvantage — Installation is considerably more expensive than for the single-wing deflector, and suitable sites are limited by bank height.

Cost — One pair of tip deflectors can be installed per crew day on streams 15 to 20 feet wide.

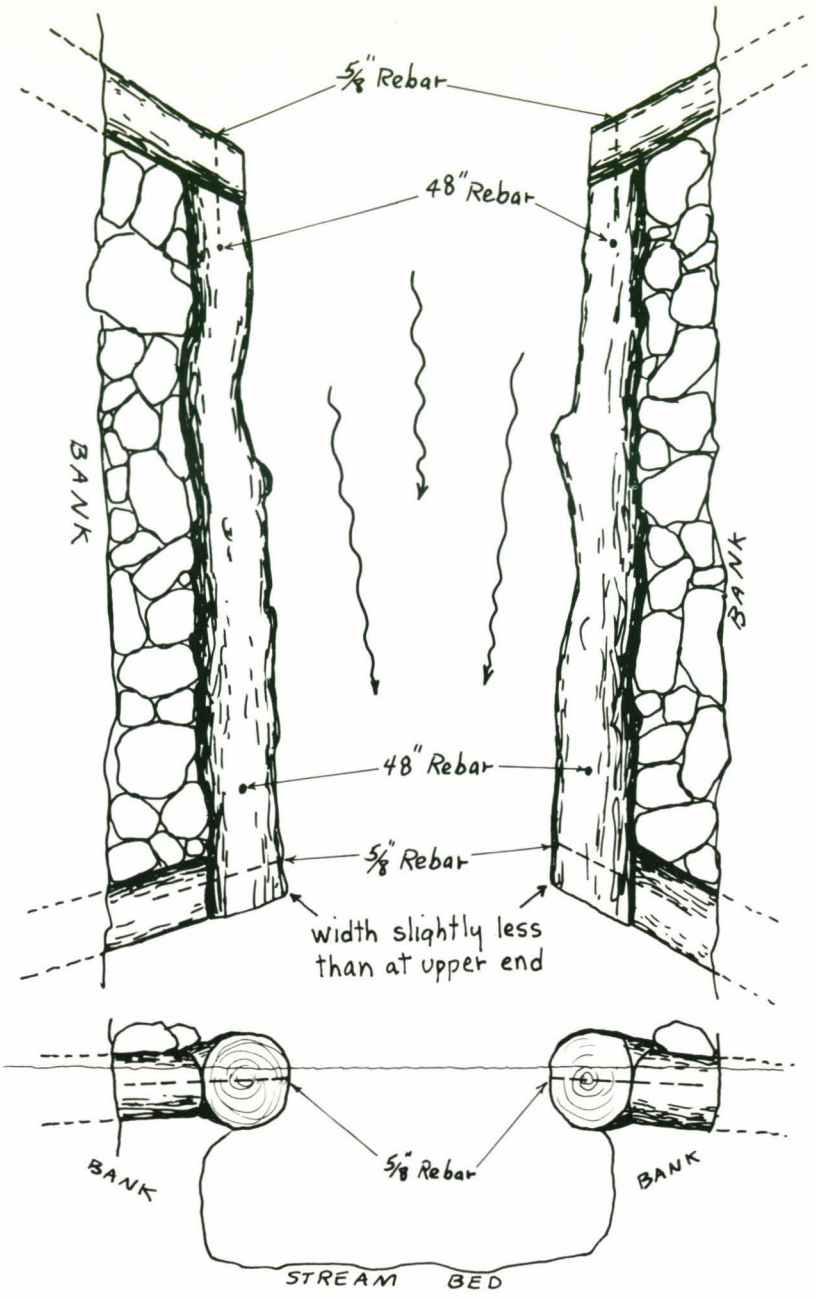


Figure 13.—Channel constrictor.

Channel Constrictor

Purpose — The channel constrictor is a modified deflector designed to create overhead cover similar to that provided by undercut banks.

Design — Channel constrictors can be placed alone or in pairs. Each structure consists of a main channel log and two brace logs. The main log is placed at a slight angle to flow (figure 13) with the two brace logs pinned to it at a 45-degree angle. The main log can be from 10 to 30 feet in length and should be as large as can be handled. A rough, crooked log often creates ideal cover. The intent is to provide an undercut the entire length of the main log (both logs if structures are paired). On smaller logs, where overhang is not created through sheer size, a slab can be sawed out of the underside of the log to provide additional space (see "Cover Log").

Channel width should be reduced by 70 to 80 percent between the two main logs (where two structures are paired opposite), with slightly less distance between the lower ends than the upper ends.

Placement — Channel constrictors provide best results when placed in long, straight, low gradient stretches of stream.

Advantage — The maximum amount of overhead cover is provided when installed properly.

Disadvantage — Considerable experience is needed to install these structures properly. In most cases, failure has been the result of being too conservative when constricting the stream channel.

Cost — Structures with main logs in excess of 10 to 15 feet in length require much fill material. One pair per day would be a reasonable output.

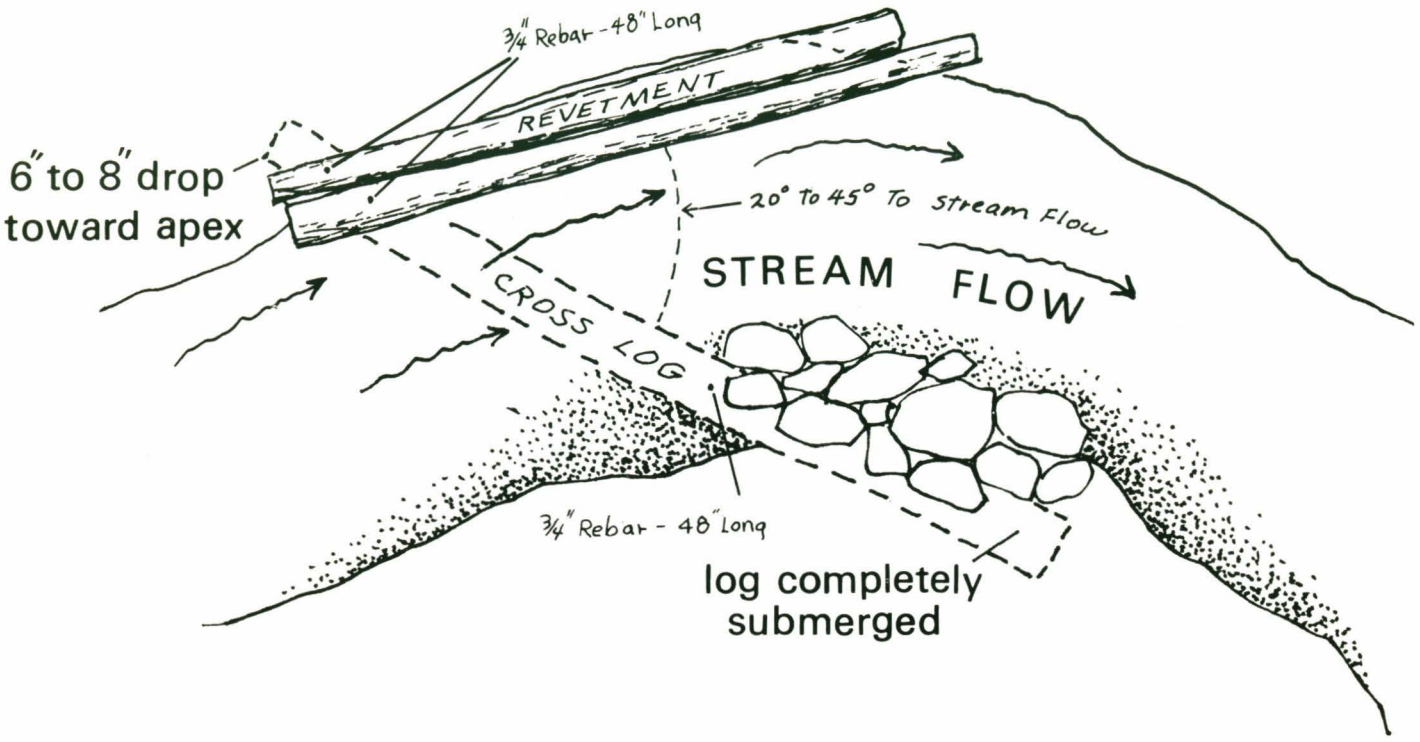


Figure 14.—Cross log and revetment.

Cross Log and Revetment

Purpose — This structure is designed to create a scour pool either by water pouring over the top of the cross log or forcing its way underneath. Revetment logs create overhead cover and protect the bank at the same time.

Design — The cross log is dug into the streambottom at an angle of 20 to 45 degrees to the direction of streamflow, with the revetment log placed at a slight angle (10 degrees) to streamflow (figure 14). The apex (junction of cross and revetment logs) should be upstream, with that end of the cross log at least 6 inches lower than the other end. Both ends of the cross log should extend 3 or more feet into the bank, depending upon bank stability. Revetment and cross log are pinned together into the streambottom with 48- by 3/4-inch rebar. The lower ends of both logs are then pinned to the streambottom with 48- by 3/4-inch rebar. As a general rule, the revetment log is notched halfway through where it joins the cross log.

Placement — These structures should work best in low gradient sections of stream. They can be utilized in straight reaches, but should provide best results when placed at the beginning of wide, shallow bends with no well developed pool or cover.

Advantage — This structure requires only on-site materials, and presents a very natural appearance. It does not require well defined streambanks.

Disadvantage — Since the best results are obtained in existing streambends where pools and cover are lacking, potential sites are somewhat limited.

Cost — A crew should be capable of installing two to three structures per day in streams 10 to 15 feet wide.

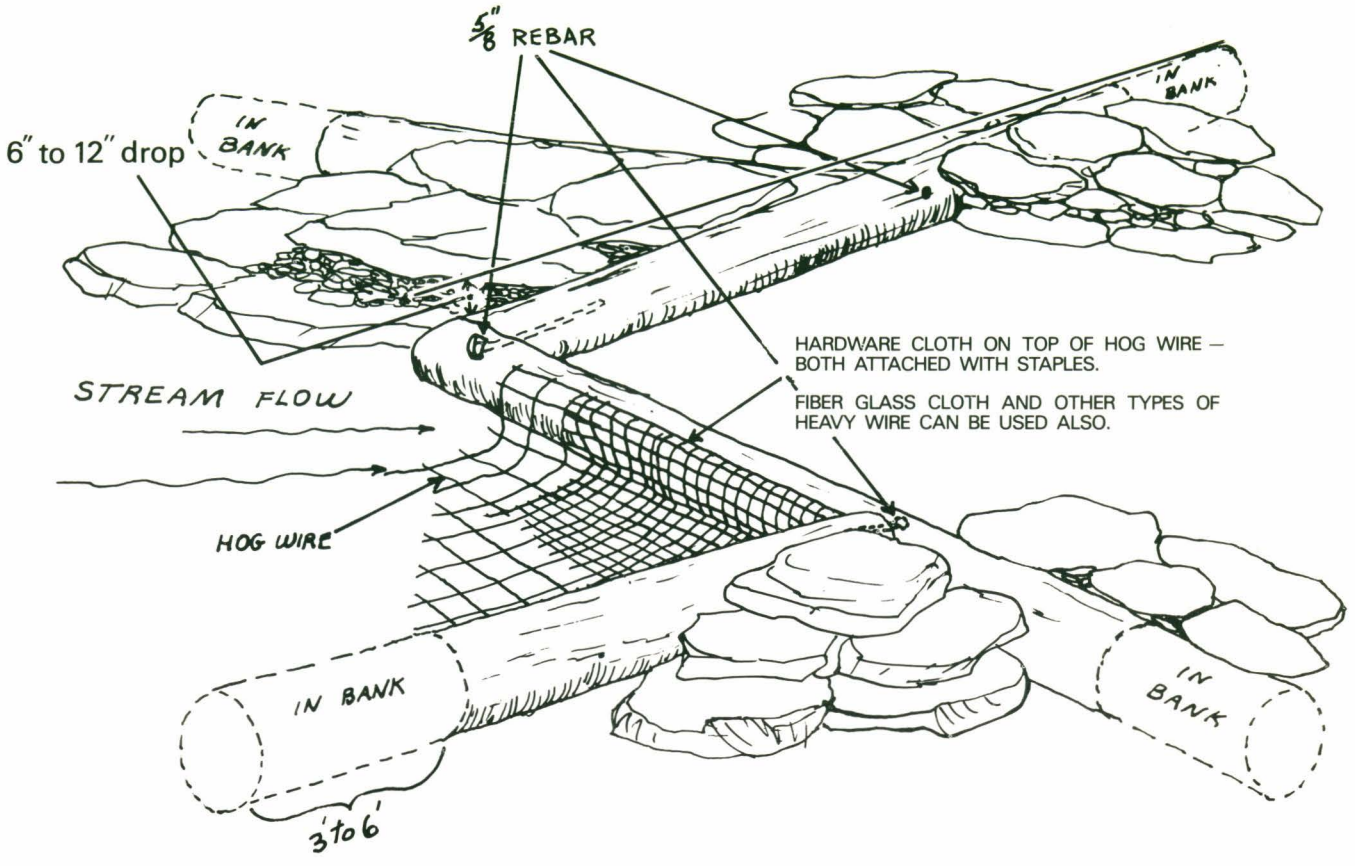

5/8" REBAR
6" to 12" drop
IN BANK
IN BANK
HARDWARE CLOTH ON TOP OF HOG WIRE – BOTH ATTACHED WITH STAPLES.
FIBER GLASS CLOTH AND OTHER TYPES OF HEAVY WIRE CAN BE USED ALSO.
STREAM FLOW
HOG WIRE
IN BANK
IN BANK
3' to 6'

Figure 15.—Wedge dam.

Wedge Dam

Purpose – The primary purpose is to create pools or deeper water in shallow sections of stream. In continuous steep gradients, a major benefit of such structures is the break in gradient, providing resting areas for fish. The short "flat" above some structures often holds more fish than the deeper pool below. The quiet water above the structure and at the edges of the pool below also acts as a trap for organic material utilized as food by stream invertebrates.

Design – The two main logs in the dam face upstream at a 45-degree angle to streamflow, while the two brace logs are pinned to the main logs at approximately a 90-degree angle to the main log (figure 15). Butts of the two main logs extend into the streambank 3 to 6 feet, depending upon stability of the bank (further in unstable soils). A 6- to 12-inch drop along the top of the log from the bank to the apex is desirable, and is usually achieved through log taper and by digging the trench deeper at the apex than at the bank. The main logs should be dug into the stream bottom as deeply as possible. Logs should be as large as possible, but at least 10 to 12 inches in diameter for small streams (less than 10 feet wide) and 14 to 16 inches in larger streams.

Once the logs are in place, hogwire or another heavy wire, such as chain link fencing, is stapled to the upper side of the log. Then hardware cloth or some type of fiberglass cloth is placed on top. The cloth or small mesh wire seals the structure, and the heavy wire provides strength to hold the fill material in place. A layer of large flat rock is placed on the wire. Next a layer of gravel is added, and then a final layer of large rock is placed on the gravel. If preferred, 4- to 6-foot boards nailed to the underside of the dam log can be used in lieu of wire. The cribs at the bank are filled with a mixture of large rock, gravel, and dirt. Spillway height should be 6 to 12 inches.

Placement – Wedge dams are generally limited to streams less than 30 feet wide. Well defined streambanks are another requirement. Ideal locations are in extensive stretches of high gradient stream or where maximum depth of a scour pool is the objective.

Advantage – Wedge dams almost always create a fair to excellent scour pool, even in heavy rubble. Small dams create more dramatic and noticeable changes than other type structures.

Disadvantages – Dams are more expensive and require more maintenance than other structures. The most common failure is washing underneath, although the wedge dam is less prone to this type failure than the "K" dam.

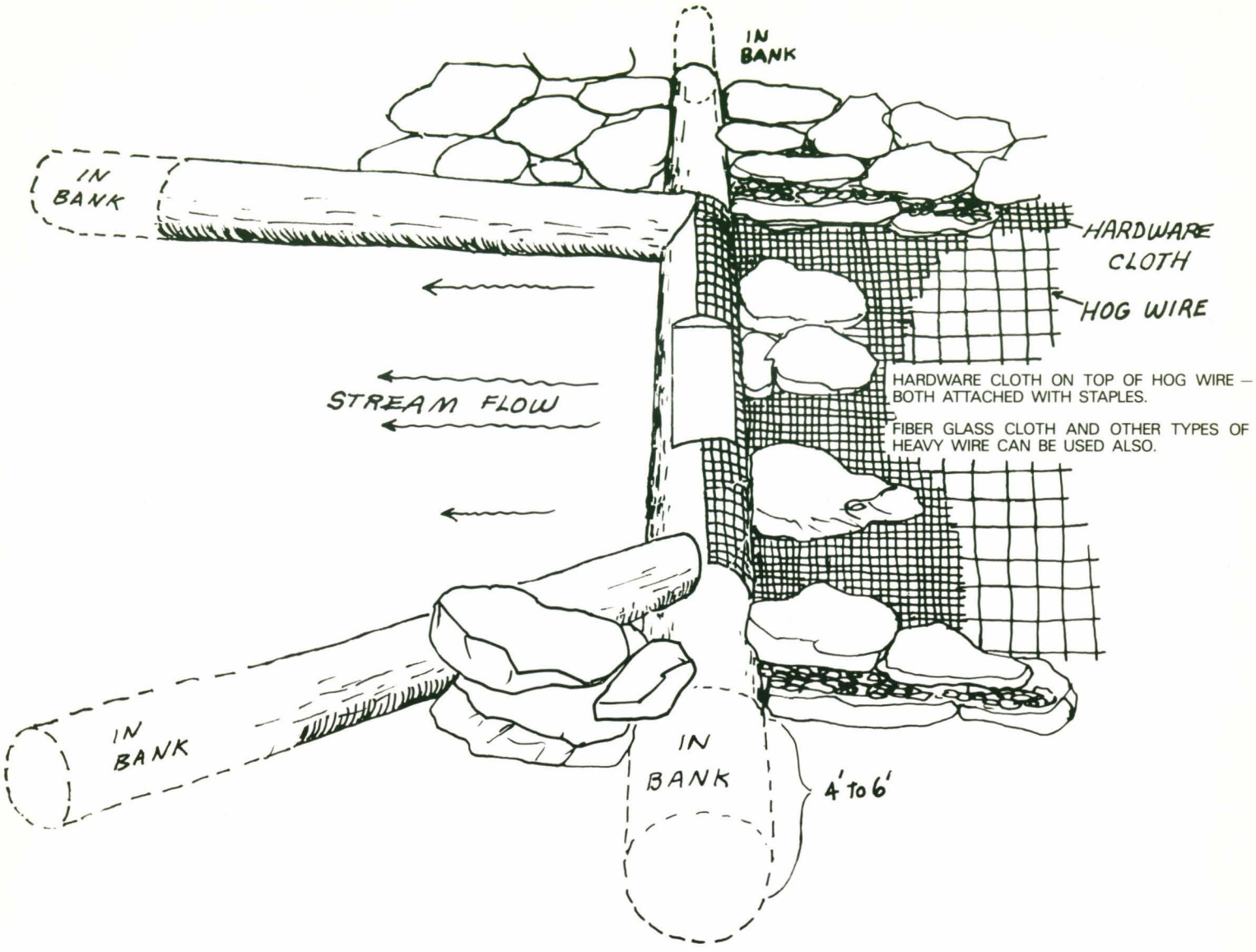

IN BANK
IN BANK
HARDWARE CLOTH
HOG WIRE
STREAM FLOW
HARDWARE CLOTH ON TOP OF HOG WIRE – BOTH ATTACHED WITH STAPLES.
FIBER GLASS CLOTH AND OTHER TYPES OF HEAVY WIRE CAN BE USED ALSO.
IN BANK
IN BANK
4' to 6'

Figure 16.—"K" dam.

"K" Dam

Purpose – The purpose of this design is basically the same as for the wedge dam.

Design – One log is used to span the entire stream, with braces placed on the lower side at approximately 45 degrees to the main log (figure 16). A brace or wing log can also be added on the upstream side when leakage around the end is likely to occur, or when unstable banks or streambottom are special problems. Placement of wire and fill material is similar to the wedge dam. The main log should be at least 16 inches in diameter, if available, and should be dug 4 to 6 feet or more into each bank and as deeply into the streambed as possible. A spillway should be cut into the log to concentrate low flow to the center of the stream.

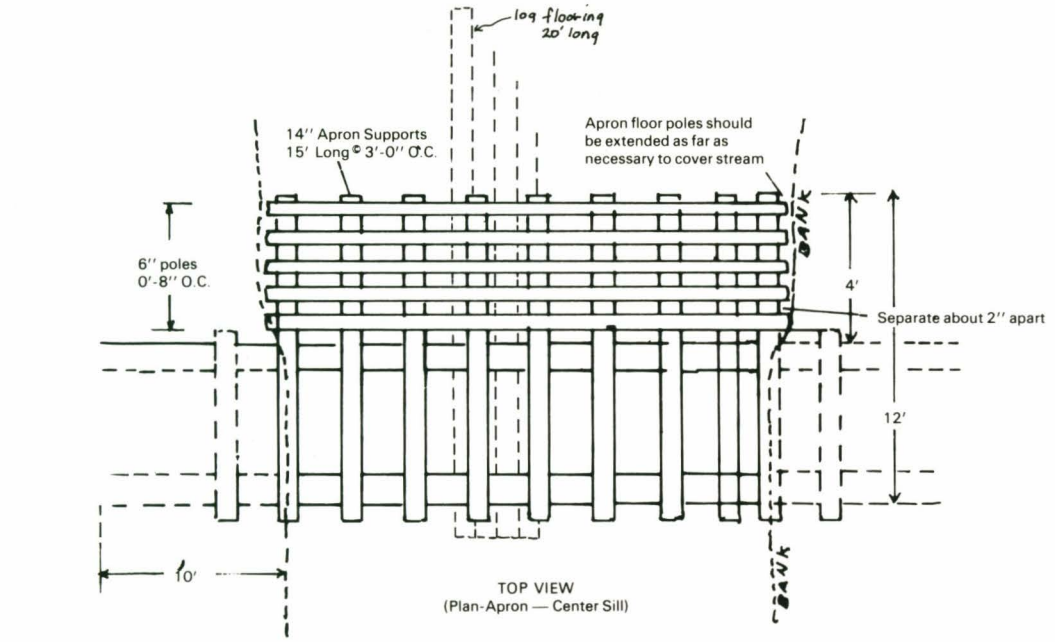
Placement – Placement is similar to that described for the wedge dam, however K-dams are best suited for streams less than 15 feet in width.

Advantage – Pools tend to be slightly larger and deeper than those created by wedge dams, although the wedge dam is a better overall design from the standpoint of maintenance and stability. A combination of the two structure types enhances the aesthetics of projects in small streams.

Disadvantage – Installation is more difficult and time consuming than for wedge dams, primarily due to the more extensive excavation required to seat the main log securely in the bank.

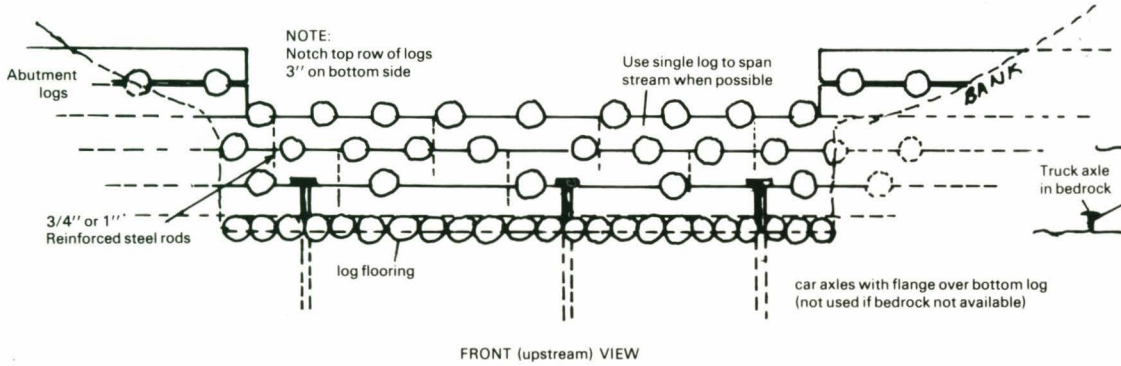
A single large log must be used to span the stream, increasing the difficulty of hand placement. The chance of washout is greater than for the wedge dam, since the main log is usually not seated as deeply into the streambottom.

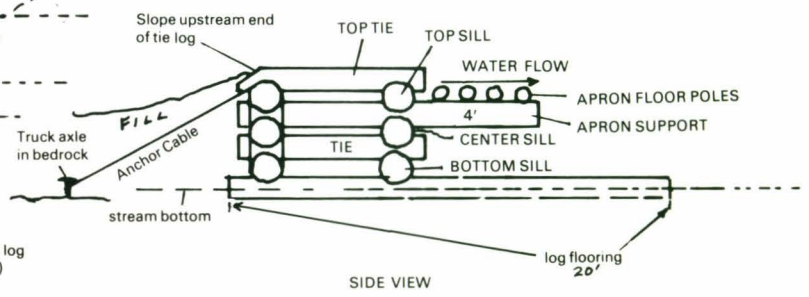
Cost – One structure per crew day can be installed in streams 10 to 15 feet wide.



NOTE:

1.) Bottom sills should be anchored to bedrock, if possible, with 1" or bigger steel rods. Old car or truck axles are suitable for this purpose.
2.) All log sizes are approximate but should be selected to make dam at least 6' high, if possible
3.) Crib can be filled with rock as construction progresses, or it can be filled after construction.
4.) Ends of barrier to extend a minimum of 10'-15' into bank when banks are not solid rock.
5.) Top sill log (spillway) should be level all the way across, or have a gradual dip toward the center.
6.) Upstream side of structure should be filled with selected rock and gravel to a maximum slope of 4: 1
7.) Use hemlock or other decay resistant logs.
8.) ¾" or 1" reinforcing steel should be used to tie sill logs.
9.) ⅝", or ¾" reinforcing steel rods should be used to anchor tie logs to sill logs.
10.) Use single logs for sills when possible.





Revised
M. Seehorn
Barry Nehr

Figure 17.—Fish barrier.

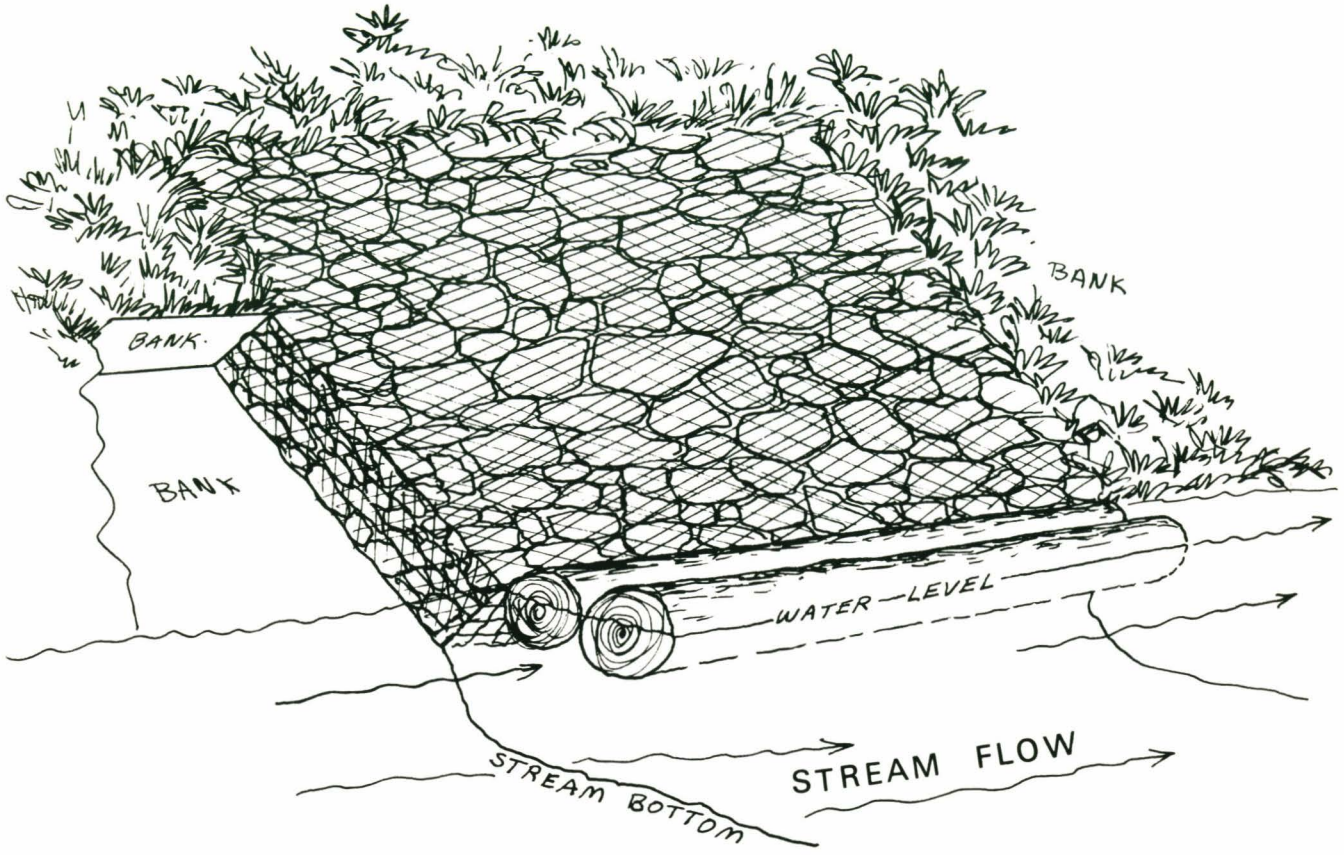


Figure 18.—Cover log attached to gabion.

Fish Barrier

Purpose – Fish barriers are installed to prevent the upstream migration of undesirable species of fish. In some cases, the objective is to exclude warmwater fish from waters managed for trout. In other cases the objective might be to exclude rainbow and brown trout from brook trout waters.

Design – The design is basically a log crib filled with rock, incorporating a log apron and log floor to reduce chances of fish jumping the barrier (figure 17). Overall height of the structure can be 6 feet or less since the log flooring precludes formation of a jump pool. The pool above the structure should be back-filled with coarse rubble and boulders when available.

Placement – In selecting a location, it is essential that streambanks be high enough to handle flood flow without bypassing the structure. It is also desirable to cable or attach the structure to bedrock where possible.

Cost – Heavy equipment is essential when building barriers on streams over 20 feet wide. A front end loader is considerably more cost effective than nand labor in moving large logs and fill material. A crew of 8 to 10 workers with heavy equipment, logs, gravel, and other materials conveniently available should complete a structure on a 20- to 30-foot wide stream in 2 to 4 days.

Gabions

Gabions may be substituted for logs when building deflectors, small dams, and other instream improvements on sites where rubble or other proper size rock is available. The durability of gabions on southeastern streams has been poor, however, when compared to log structures. Other disadvantages include higher costs and poor aesthetics. Where proper size logs are available, they should be used instead of gabions.
ed to an existing gabion structure are, in some cases, however, quite effective.

SUGGESTED READING

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